

Wind and Solar Forecasting Research Needs *Grid Operations Perspective*



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EPRI Variable Generation Forecast Integration Efforts



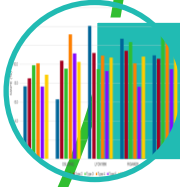
Fundamental Research on Forecast Integration



White Paper on Forecasting State of the Art



Behind the Meter PV Impact on Load Forecast



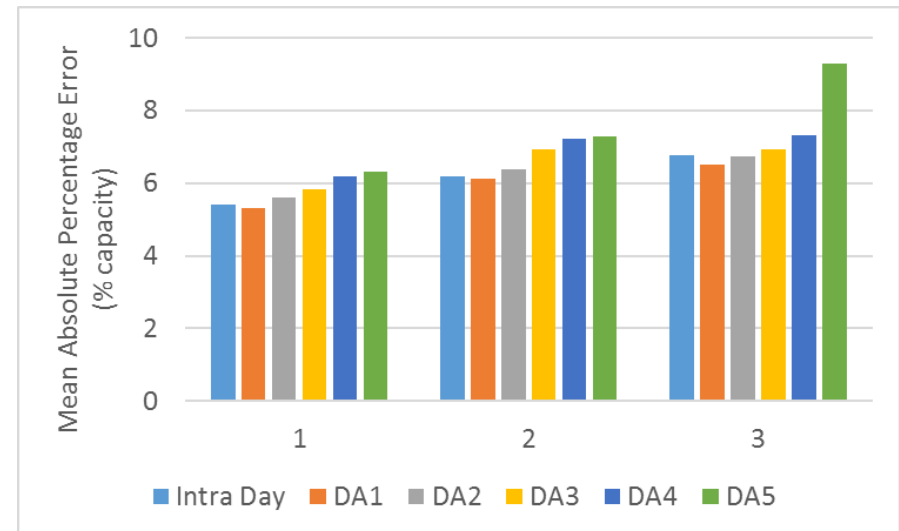
Solar Forecast Performance Utility Trials



Sensor Deployment and Advanced Forecasts

Solar Forecasting Trials in Texas, Georgia and California – Insights into Current State of the Art

- Significant variation in forecast performance among providers
 - Improvements were seen over the course of multiple trials
 - Results indicate a potential need to improve short term forecasts, as they were not much better than day ahead
- Metrics used are important in assessing the forecast performance
 - Different end users are focused on different aspects of operations
 - Link between wind/solar forecast and load forecast, and times of day/year of higher risk need to be understood and exploited
 - Multiple metrics were used to help utilities assess forecasters that perform best in different conditions



Results for one site in California for 4 months for different look ahead horizons

Need tools and methods to compare and baseline new forecasting techniques

Potential Areas of Forecast Value

Dollar Value

- Improved dispatch efficiency
- Reduced balancing and operating reserve requirements
- Reduction in curtailment of variable generation
- Reduced losses
- Reduction in need for new flexibility resources
- Customer outage reduction
- Lower electricity prices

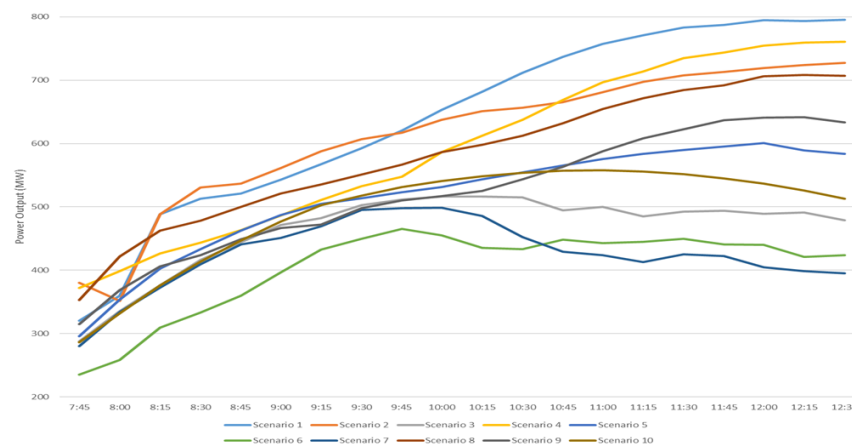
Additional Value (may also have \$ value)

- Improved reliability (e.g. Area Control Error)
- Reduced emissions
- Resiliency: Reduced outage magnitude and length (SAIDI, SAIFI)
- Improved safety
- Dynamic Line Ratings
- Improved DER integration

Need a better tool kit to capture value of improvements in forecasts in different operational environments and end uses

Probabilistic Forecasting Methods

- EPRI studies have shown potential benefits of using probabilistic info.
 - WECC system study to examine potential use of this info
 - Showed that use of probabilistic forecasts can improve reliability and/or economics over current deterministic methods
- Research needs identified in area of probabilistic forecasting
 - Improved probabilistic forecasts that capture the uncertainty in a suitable narrow band
 - Operational tools that can use such forecasts to assist decisions, e.g. operating reserve requirements
 - Education on how these tools could be used and further developed
 - Identifying different use cases – ISO and utility use cases



PV output scenarios

Probabilistic forecasts can improve operations and provide situational awareness– but we need to know how best to use them

Upcoming White Paper on Renewable Forecasting

- Aim to understand current state and what can be done in future
 - Propose further R&D
- Focus on wind and solar, but load forecasting is key
 - Need to exploit links between load, wind and solar forecasting
 - Different values should stack together (similar to storage?)
- Looking for feedback from utilities, ISOs and other stakeholders
 - Contact if interested

Wind and Solar Power Forecasting: An Evaluation of the Current State of Technology and Likely Focal Points for Advancements

The penetration of wind and solar generation on power systems is growing rapidly making forecasting of the output of these plants an increasingly important activity in power system operations in order that variability can be mitigated in the most effective manner possible. EPRI has been working on several projects, at various stages of completion, related to wind and solar forecast integration into system operations. This includes management of utility specific solar forecasting trials and deployment of new technologies such as Lidar, sky imagers and other instrumentation. Technology watch has also been carried out in previous years on forecasting technologies and how forecasts are used in operations. This white paper evaluates current developments in forecasting and identifies and comments on perceived forecasting needs as articulated by end users and providers. It also identifies pathways currently being used to integrate forecasting technology into system operations, and discusses ways beyond accuracy improvement in which forecasts can be made more valuable to operations.

The paper is aimed at the senior management/executive level to provide EPRI thought leadership in guiding the industry in this topic. The material was developed through reference to past EPRI projects (references), from the authors' subject matter expertise and from interviews with subject matter experts at forecast service providers, utilities and system operators.

Introduction to Renewable Energy Forecast Production

[Not everyone has access to the 2013 report. Can duplicate some, esp. in Ch 3.

Summarize key information from Ch 2-3 of the 2013 paper, from interviews and from IEEE papers in an executive summary form. Include:

- How increased RE affects the big picture (wind, solar and load) and the interplay of generation and load variability/uncertainty. Especially, what it means especially to total variability and uncertainty now, as penetration increases (where it will peak), and at very high penetration (where regional scale variability will reduce due to often having more instantaneous RE capacity than there is demand).
- High level overview of forecasting sausage making emphasizing
 - The necessary partnership between provider and user
 - No one size fits all
 - Data and meta-data are crucial
 - Similarities and differences between wind, solar and load (in methods, observations, integration)

Describe current state and identify issues for further R&D



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